Averting orbital apocalypse

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In the silent vacuum of space, an anonymous CubeSat (miniature satellite) crashes into a U.S. national security satellite, rendering the nation vulnerable and without the ability to identify the responsible party. This type of hit-and-run space traffic scenario is one the nation's military and intelligence communities fear for the near future, as more private companies commission thousands of CubeSats—4-inch cubes, shorter than an average smartphone.

"CubeSats give the common man access to space; you don't need a billion dollars to get to space anymore," explains Los Alamos mechanical engineer Dan Seitz. At a reasonable price of $40,000 or less to launch, these 3-pound satellites allow anyone in the world to purchase his or her own CubeSat and send it to space aboard a large rocket.

The exponential boom in demand for commercial CubeSats comes from these satellites' ability to gather data needed for important predictions and studies. For example, CubeSats can track port traffic and agricultural patterns for predictions of economic growth, or they can gather environmental data for studies of global warming.

Commercial CubeSats can also offer services, such as internet and radio. There is great economic opportunity for companies that take to the sky, but as more and more companies do just that, the skies become overcrowded, which is why traffic congestion in space is now a hot-button issue.

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"To maintain U.S. leadership in space, we must develop a new approach to space traffic management," the National Space Council states in its Space Policy Directive-3, issued June 18, 2018. David Palmer, a Los Alamos space and remote-sensing scientist, has designed that new approach. It's an extremely low-resource optical identifier (ELROI)—an electronic license plate technology for space.

ELROI uses a laser diode to communicate a unique serial code that identifies a CubeSat, attributing a name to who is responsible for each satellite in space. The laser on a CubeSat blinks 1,000 times each second, with each blink lasting only a millionth of a second. The blink-nonblink pattern is like a binary code of ones and zeros that translates to a serial code. Back on Earth, that code is detected by a corresponding telescope filtered to the laser's specific wavelength, and the CubeSat is identified by name and position.

Currently, larger satellites use radio waves powered by many watts of electricity to communicate their name and position back to Earth. But this technology performs only

if the satellite is working and can afford to use that much power for communication. "There are 5,000 space objects with payloads in space, but a mere 2,000 are working and able to identify themselves," Palmer explains. Because the number of space objects is expected to more than quadruple in the next few years, this issue of unidentified space objects cluttering the skies must be addressed.

The benefit of ELROI is that it can identify a satellite whether the satellite is working or not because each ELROI is powered by its own rechargeable solar cell. The wattage used for ELROI is about that of a refrigerator light when ELROI is on, which is only 1/1000th of the time, thanks to its blinking on and off. Overall, it consumes about as much power as a laser pointer (when averaged over a second or longer) and costs the satellite nothing to operate, in terms of power.

ELROI is the size of a Scrabble tile.

The ultimate plan for ELROI, which initially rode to space in December 2018 and will be part of two more launches in 2020, is to enforce space safety. "The vision is to have an ELROI license plate on every object that gets registered for space launch," Palmer says. At an expected cost of less than $1,000 per unit, the tiny ELROI (no larger than a Scrabble game tile) will be a simple solution for a growing problem.

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